PREVIOUSLY….

Different areas of the retina capture information from specific parts of our surroundings.

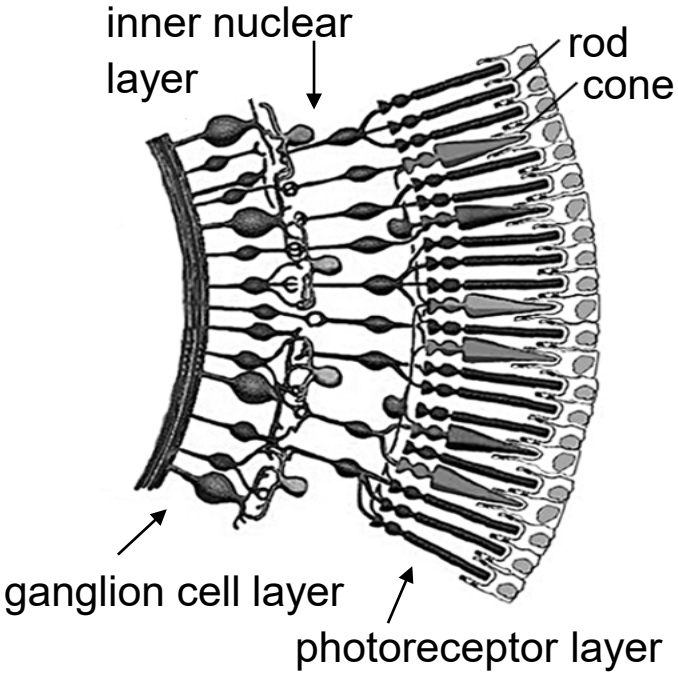
The ratio of retinal ganglion cells to photoreceptors determines sensitivity vs acuity

Variation in the number of retinal ganglion cells across the retina means that different parts of our surroundings can be processed differently!

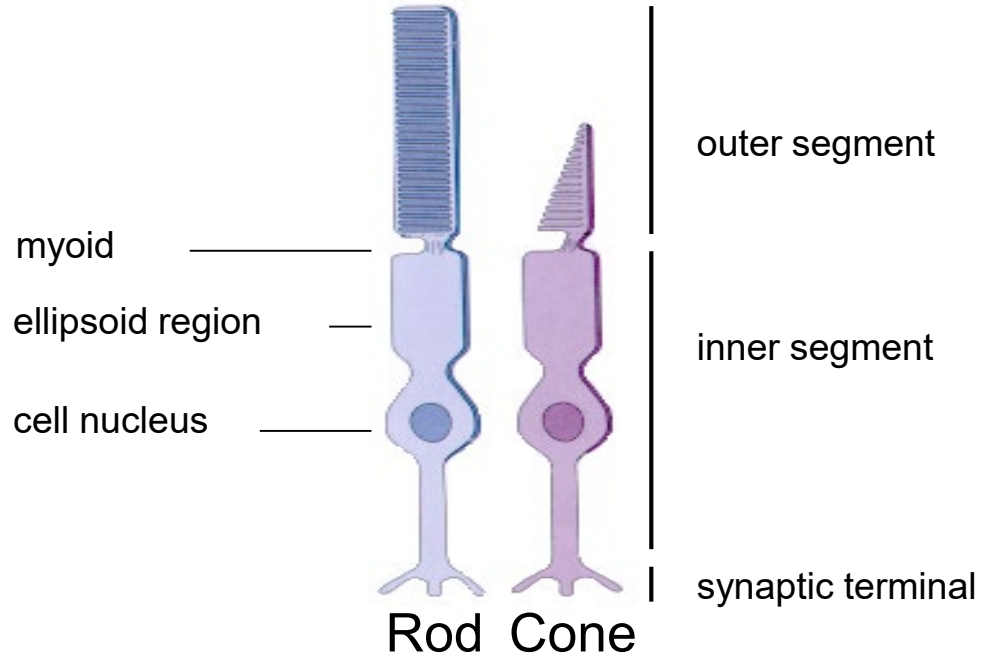
Retinal ganglion cell distributions reflect visual priorities (tasks), light environment and phylogeny

THIS video: What about the photoreceptors?

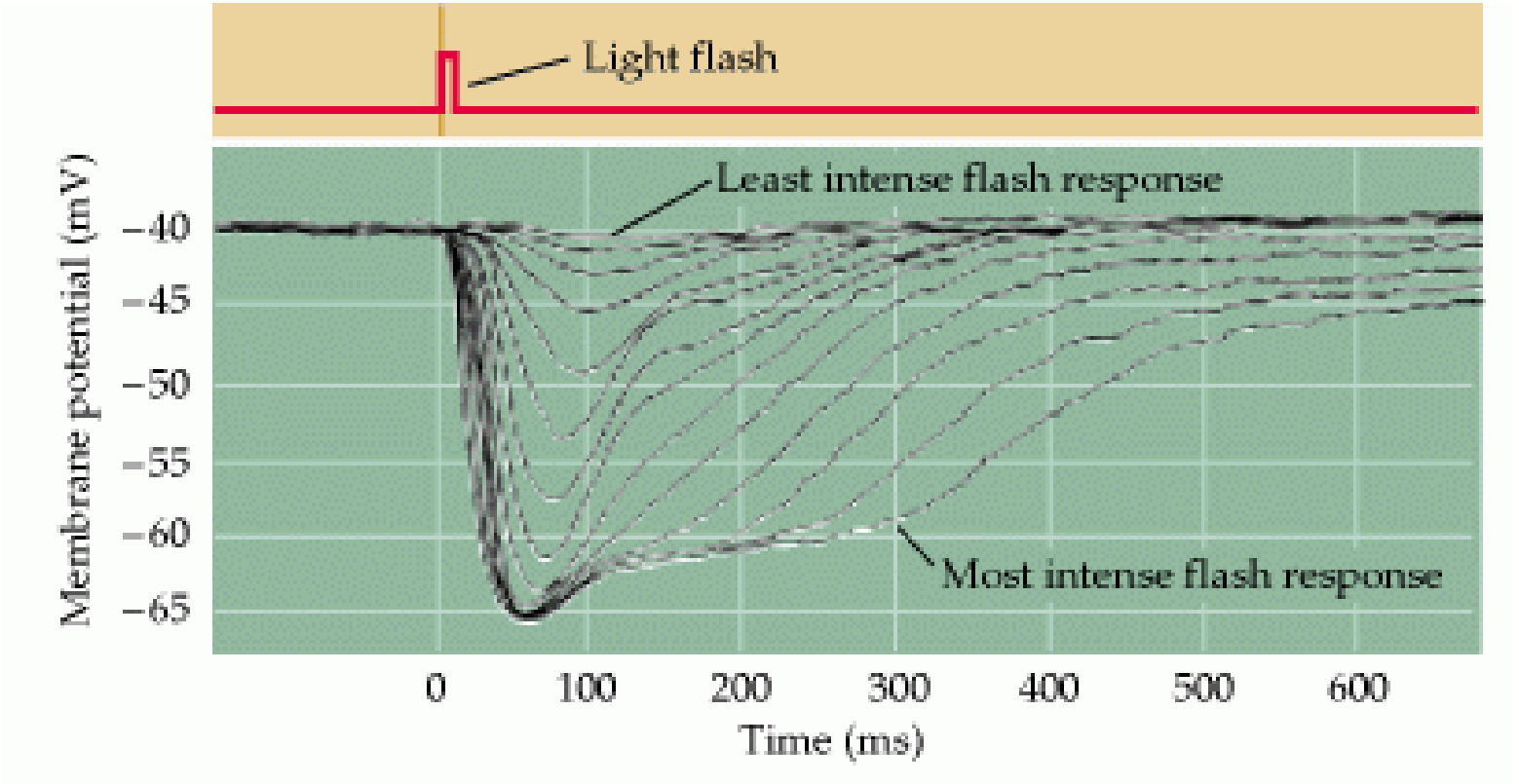
What about the photoreceptors?



Photoreceptor organisation

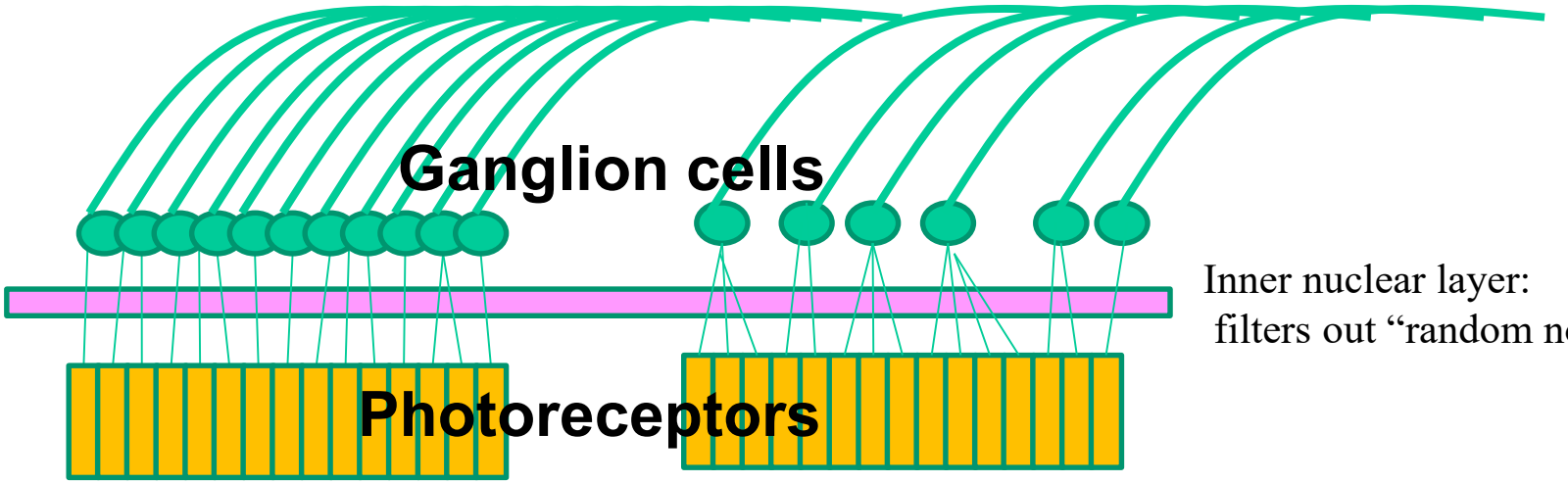


- Outer segment: light converted into electrical signals
- Inner segment: biosynthetic and oxidative processes
- Cell nucleus
- Synaptic termination: transfer of information



- Photoreceptors hyperpolarise proportionally to the number of photons absorbed and do not fire action potentials

SUMMATION



Inner nuclear layer:
filters out "random noise"

ACUITY **SENSITIVITY**

- More photons means more probability that the photoreceptor will activate a ganglion cell
- Converging multiple photoreceptor inputs onto a single ganglion cell maximises the chances that a weak light signal will be picked up by the brain

Photoreceptors: rods and cones

Rods:

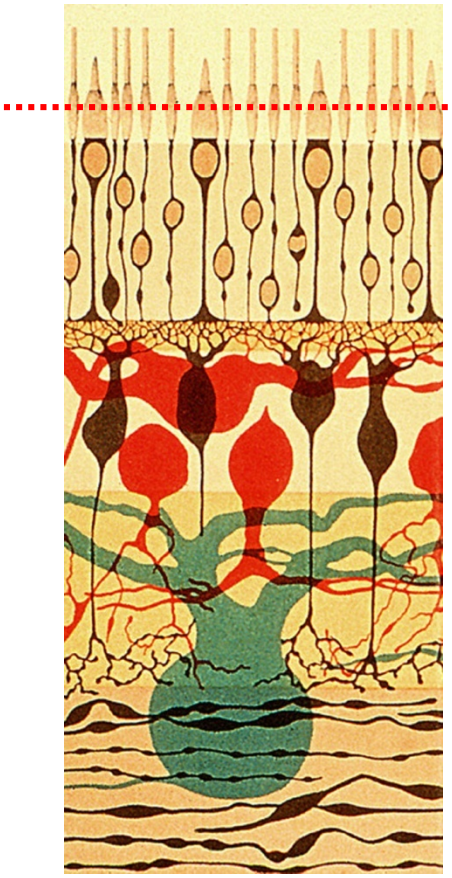
- long, cylindrical outer segments
- highly sensitive to light (1 photon!)
- mediate scotopic (night) vision

Photoreceptors: rods and cones

Cones:

- shorter, conical outer segments
- 5 times less sensitive to light
- mediate photopic (day) vision
- mediate colour vision

Photoreceptors: cones + rods



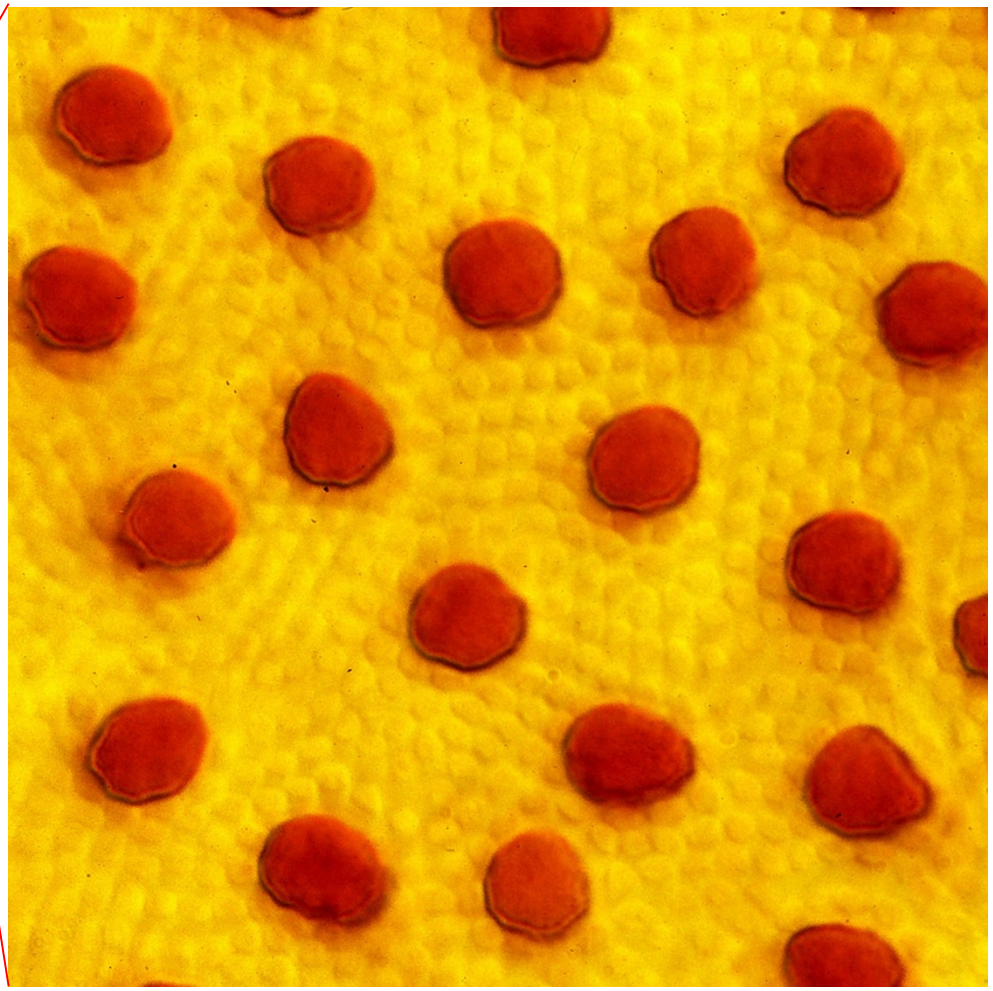
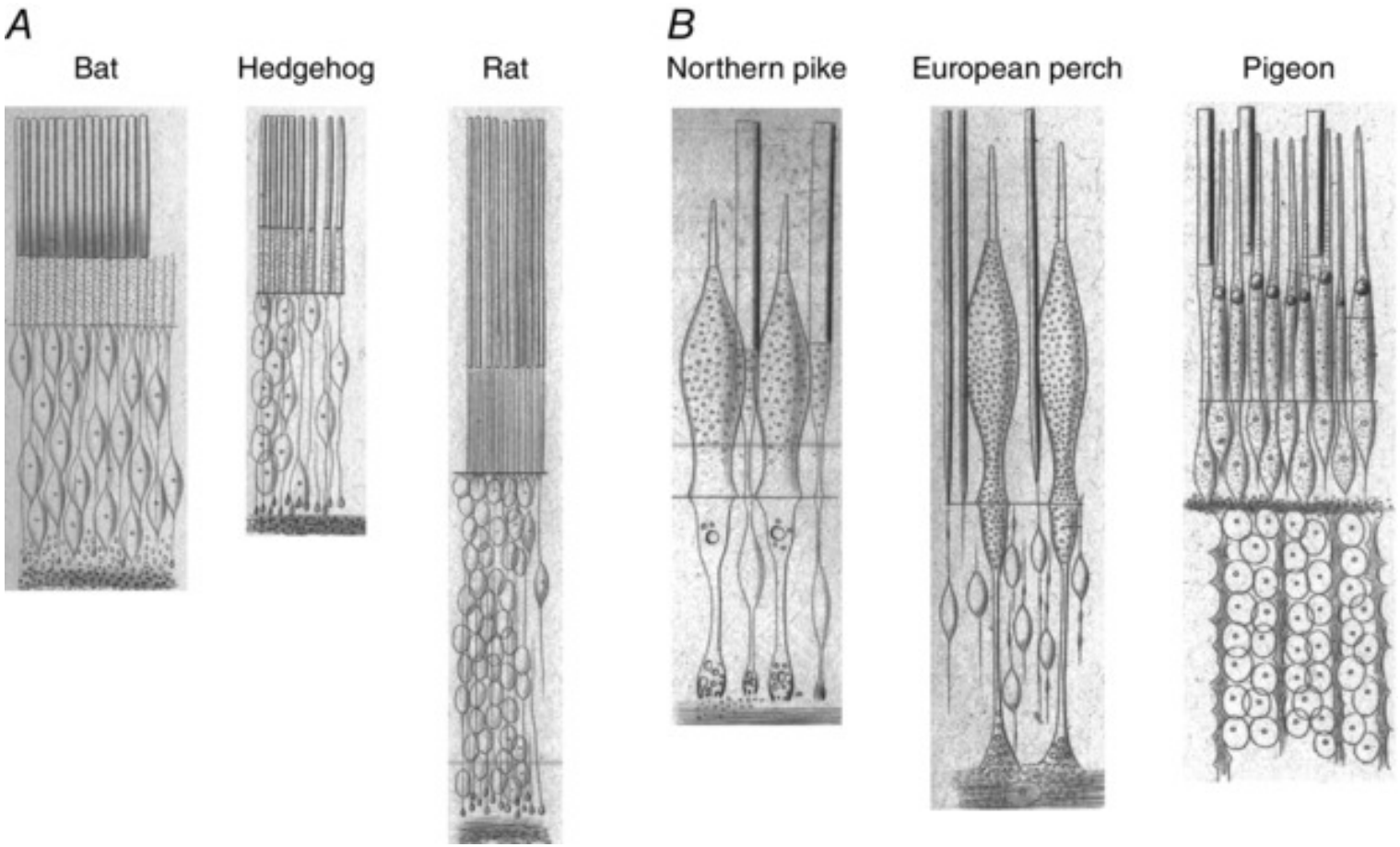


Photo: H. Wässle

Cones: daylight vision, colour vision

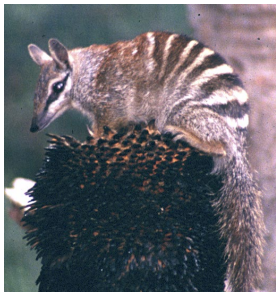
Rods: night vision



Rods and cones in nocturnal and diurnal animals
Drawings from Schultze's original paper (1866) of photoreceptors from nocturnal animals (*A*) and diurnal animals (*B*), magnification approximately 350–400 times. Schultze claimed that the bat retina lacked even a trace of cones, but in rat he noticed occasional gaps (*Lücken*) which he speculated could possibly correspond to cones, as we now know to be true. Fish and pigeon on the other hand have many easily observable cones in addition to rods. Schultze commented that these observations 'would seem to indicate that rods are more advantageous than cones for quantitative light perception', but that 'cones would seem to be the nerve end-organs for colour perception'.

Rod:cone ratio

- high = nocturnal
- low = diurnal



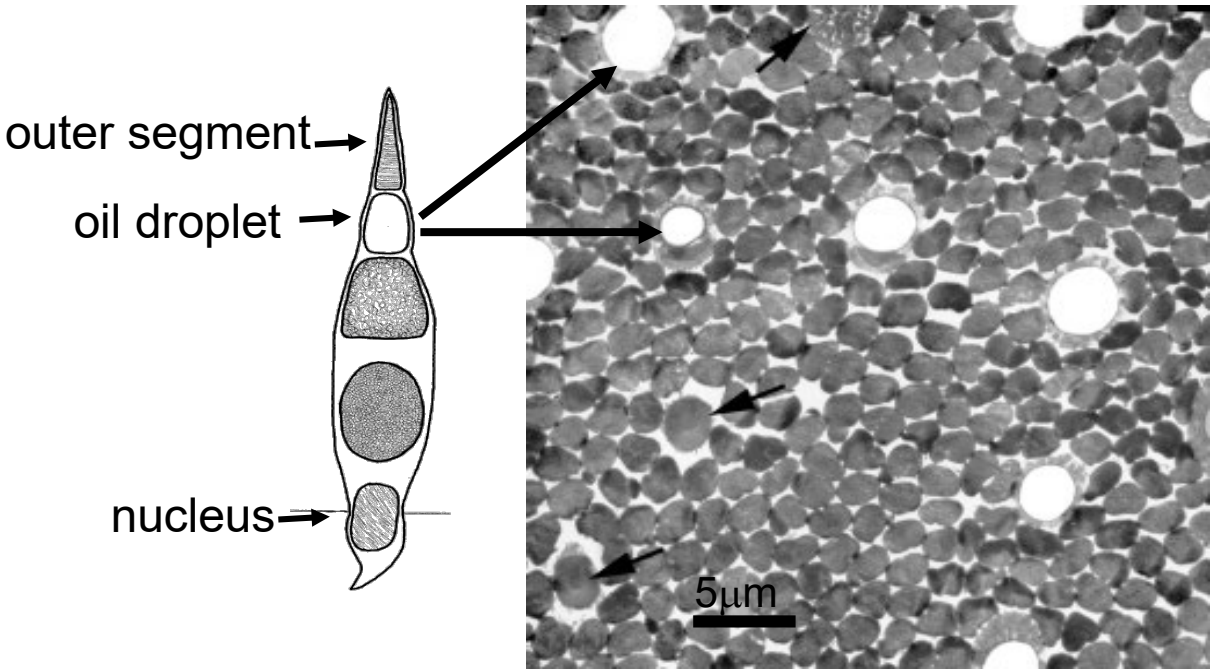
Honey possum	20:1
Fat-tailed dunnart	40:1
Numbat	1:13
Mouse and rat	100:1
Sheep	30-40:1
Human	20:1

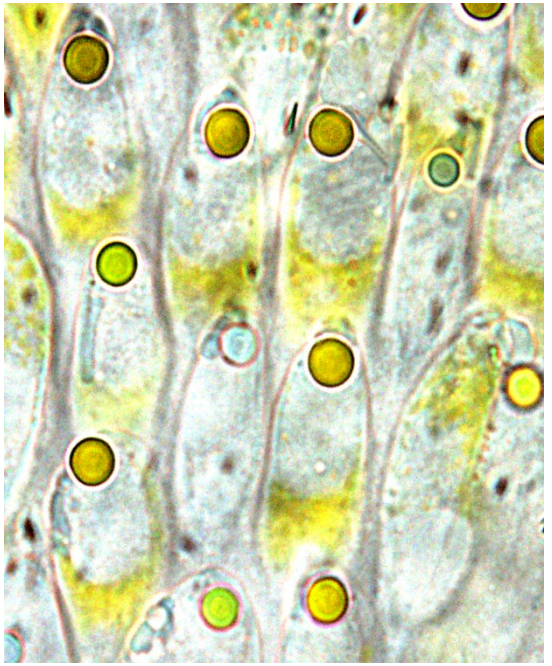
Unusual aspects of photoreceptors

(ie. Not found in humans!)

Photoreceptors: oil droplets

- absent from placental (eutherian) mammals
- **present in birds, reptiles and marsupials**

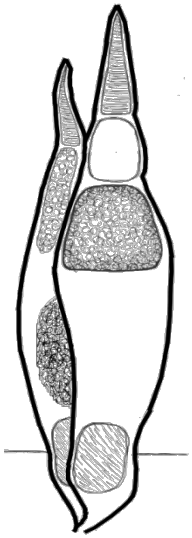


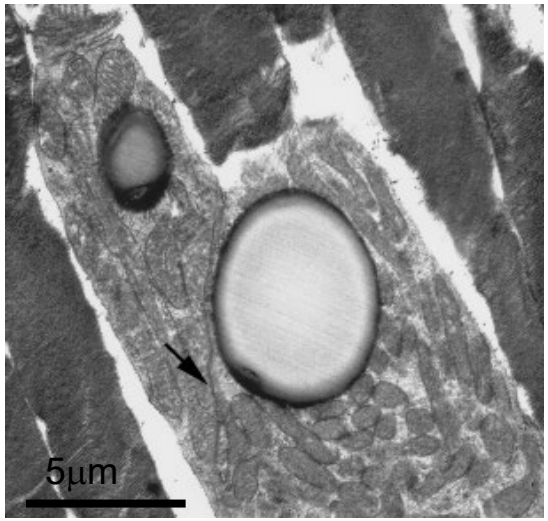


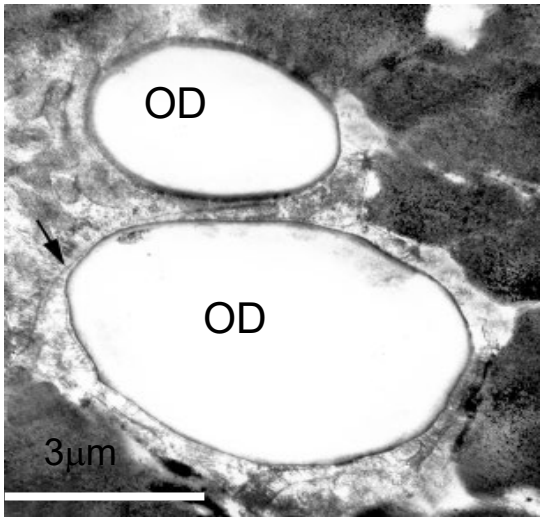
- colour vision: spectral filters
- UV transmission
- gather and focus light onto cone outer segment.
- protection of visual pigments.

Photoreceptors: double cones

- absent from placental (eutherian) mammals
- present in birds, reptiles and marsupials





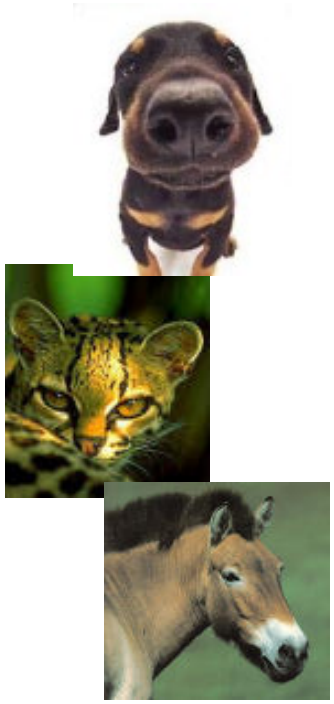


- increase surface area to optimise photon capture
- enhance movement detection

Dimensions of cones = two groups*

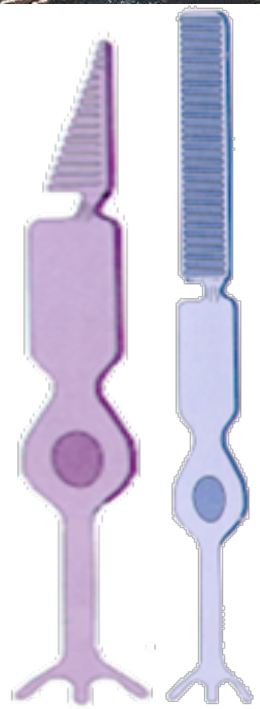
I: Mammals: “rod-like”, shorter than rods

II: reptiles, marsupials: wider, shorter



outer segment (OS)

inner segment (IS)

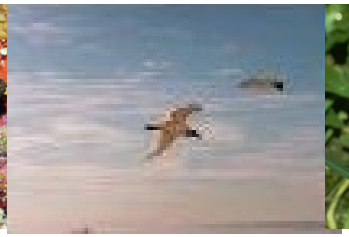


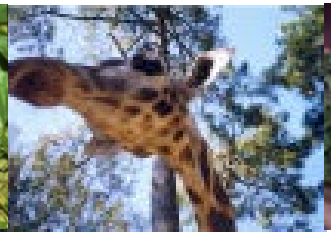
non-primates*

Retinal specialisations

2. light environment:
   - activity pattern: diurnal, nocturnal, crepuscular, arhythmic


   - habitat: aquatic, terrestrial, sky, open land, dense forest, underground etc…




Summary of key concepts:

More insight into summation: photoreceptor physiology

Photoreceptor distributions reflect light environment and phylogeny

NEXT video: How do we collect this data?

Summary

Photoreceptor distributions reflect light environment and phylogeny